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Exceptional sea turtle nest records in 2011 suggest an underestimated nesting potential in Sicily (Italy)

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Abstract. We report seven nesting events by loggerhead sea turtles in Sicily (Italy) in 2011. In comparison to past records, this number is relatively high and may be at least in part due to an awareness campaign carried out in 2011 to solicit such reports. This suggests that Sicily may host a much higher nesting activity than previously thought and higher monitoring effort is recommended, especially in certain coastal tracts. Sand temperatures and incubation periods indicate that the beaches monitored so far in the southern coast are not optimal for development, resulting in low hatching success, and produce a majority of males. Five 2011 nests and two past nests from the same area had mtDNA haplotype CC-A2.1, the most common in the Mediterranean.

Keywords. *Caretta caretta*, sea turtle, distribution, nesting, Mediterranean.

INTRODUCTION

Loggerhead sea turtles (*Caretta caretta*) are listed as endangered in the IUCN Red List of Threatened Species (IUCN, 2011) and the main identified threats in the Mediterranean are destruction or disturbance at reproductive habitats (Casale and Margaritoulis, 2010), incidental catch in fishing gear, collision with boats, and intentional killing (Tomás et al., 2008; Casale et al., 2010; Casale, 2011) and as a whole represent a high level of threat

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(Wallace et al., 2011). The Mediterranean hosts a loggerhead population that exhibits limited gene flow with those in the Atlantic and represents a Regional Management Unit for conservation (Wallace et al., 2010). Nowadays, major nesting sites are in Greece, Turkey, Libya and Cyprus, with minor sites or scattered nesting in several other countries in the eastern basin, including Italy (Casale and Margaritoulis, 2010). Since the beginning of sea turtle surveys in the Mediterranean it was evident that Italy did not host major nesting sites (Argano and Baldari, 1983; Argano, 1992) and a recent review suggested 30-40 nests per year in Italy (Mingozzi et al., 2007) as compared with over 7200 in the whole of the Mediterranean (Casale and Margaritoulis, 2010). On the other hand, actual nesting level and distribution in Italy is not well understood yet. Many potential nesting sites have not been adequately monitored, as demonstrated by the case of south Calabria, where the most important nesting area in Italy known so far was discovered only when a proper monitoring programme was launched (Mingozzi et al., 2007). In Sicily there are potentially suitable coasts for sea turtle nesting, and nests have occasionally been reported there by tourists or local people (Mingozzi et al., 2007; Genco et al., 2008).

The aim of this study was to increase available data and have clues on potential nesting sites in Sicily. To this aim, in 2011 an awareness campaign was launched in order to solicit reports by coastal people and tourists, and data about nesting activity and egg incubation were collected. Results are here reported and discussed in terms of the potential importance of Sicily as a nesting area of loggerhead sea turtles.

MATERIALS AND METHODS

In this study, information on sea turtle tracks or sea turtles found while nesting was received from people frequenting the beaches in the night or early in the morning, possibly a consequence of the 2011 WWF's awareness campaign aimed to solicit such reports. Date of nesting was conventionally assigned as the day after the night when the clutch was laid.

Digital thermometers were placed at about 1 m distance (parallel to the seashore) from six of the seven identified nests, with probes buried at a depth of 40 cm, the approximate depth of the middle of loggerhead nests in Zakynthos, Greece (39 cm; Zbinden et al., 2006) and Cyprus (39.8 cm; Godley et al., 2001). Minimum and maximum temperatures, memorized by the thermometers, were recorded once a day and the mean was assumed to be the mean of the day (Godfrey and Mrosovsky, 1994). This was also validated with temperatures recorded every hour during three days at four nests (A, B, C, D).

Most nests were continuously monitored for all the study period, and hatchling emergence was recorded. Carapace length and weight of a sub-sample of hatchlings from three nests were measured.

Samples of dead hatchlings or embryos from nests A, D, E, F, G, and from two past nests (2005, Giallonardo; 2008, Siculiana marina) (Fig. 1) were analyzed for mtDNA haplotype. Duplication (i.e. clutches laid by the same female) cannot be excluded. A stretch of ≈ 800 bp of the mitochondrial control region was PCR amplified with primers LCM15382+ and H950- (Abreu-Grobois et al., 2006). Sequences were then compared with the haplotypes known for the species, available at the Archie Carr Center for Sea Turtle Research web site (University of Florida, USA; http://accstr.ufl.edu/cclongmtdna.html).

RESULTS

A total of seven sea turtle nests were reported to our project in the summer 2011 (Table 1) (Fig. 1). Clutches C and F were laid by the same female, identified through a flipper tag. Nests B and F did not result in any hatch and were dug 79 and 104 days after nesting respectively. No evident embryos were present in eggs of nest B, suggesting no fertilization, while almost completely developed embryos were present in nest F. Minimum incubation period (defined as the period between nesting and first hatchling emergence) of the other five nests ranged from 65 to 79 days (mean: 70.0 ± 5.4 SD; n = 5). Hatchlings did not emerge simultaneously and emergence took from 3 to 10 days. Total number of eggs ranged from 80 to 119 (mean: 97.9 ± 12.5 SD; n = 7) and hatching success (proportion of hatched eggs) ranged from 0 to 81.3% (mean: 27.4 ± 32.5 SD; n = 7).

Mean sand temperatures at a depth of 40 cm near the six monitored nests ranged from 23.2 to 28.9 °C (Table 2), with daily values ranging from 19.8 to 30.5 °C (Fig. 2).

All the seven clutches analyzed for mtDNA haplotype had the same haplotype CC-A2.1.

DISCUSSION

The number of sea turtle nests reviewed for the main island of Sicily in 2011 is very high if compared with the total of 30 nest records reviewed for the period 1965-2009

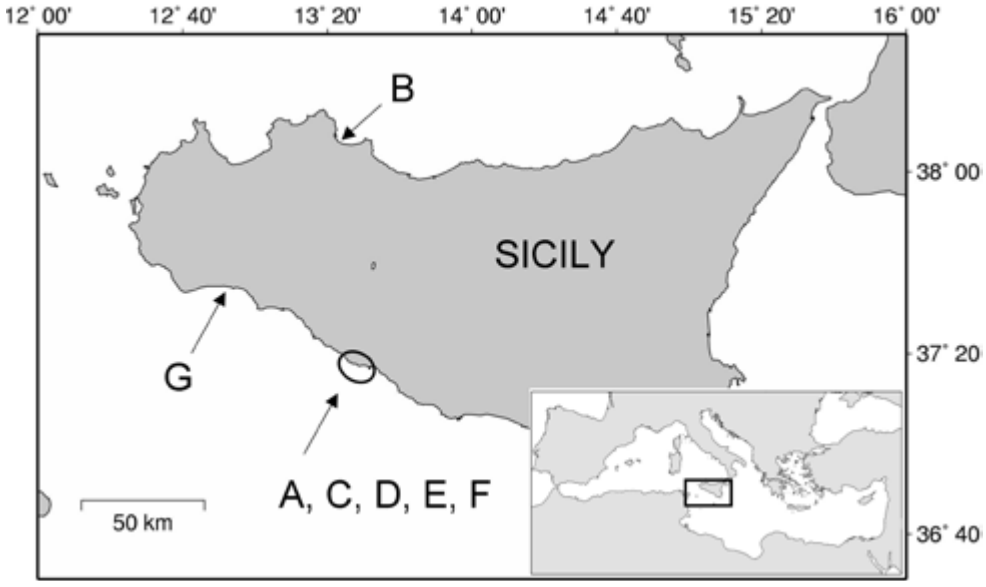

Fig. 1. Sicily island (Italy). Places where nests were found in 2011 are shown. The circle shows the coastal tract including Siculiana Marina, Giallonardo and Punta Grande where a minimum of seven nests were found in the past (see text). The inset map shows the study area within the Mediterranean.

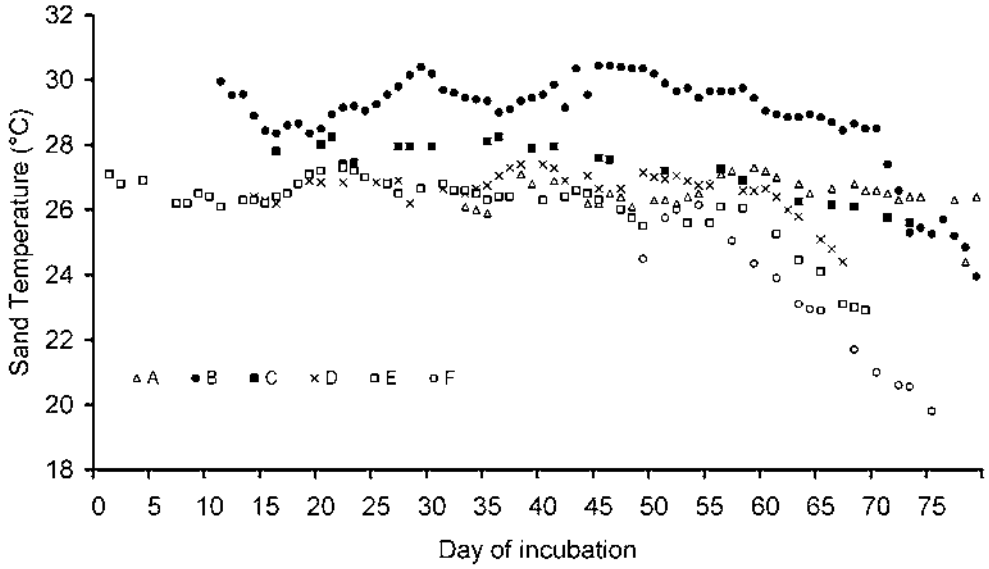

Fig. 2. Temperatures of the sand at 40 cm depth and at 1 m distance from nests (A to F).

(Mingozzi et al., 2007; Mingozzi, 2010). This may reflect an actual increase of nesting activity in the area or it may be due to a higher reporting rate by tourists and local people or a combination of the two. The fact that in 2011 an awareness campaign specifically focused on this aspect was launched suggests that reporting rate is an important and highly variable factor. It is likely that nesting activity in Sicily is greatly under-reported, and further awareness campaigns can help increasing nest records and identifying nesting sites.

During 2011, four nests were found on the same beach (Giallonardo). Since loggerhead turtles lay multiple clutches at an interval of about two weeks, with a minimum of 10 days recorded in the Mediterranean (Margaritoulis et al., 2003), dates of nesting indicate that more than one female nested on this beach, and one female nested both on this and on another beach about six km away (Punta Grande). In the tract of coast (approximately 10 km long) including Siculiana Marina, Giallonardo and Punta Grande, four nests were recorded in the period 1995-1999 (Mingozzi et al., 2007), two nests at Giallonardo in 2005 (Galia et al., 2006), one nest at Siculiana Marina and multiple tracks and hatchlings at Giallonardo in 2008 (D. Bonaviri, G. Palilla, pers. comm.), and five nests in 2011 (present results). This suggests that this tract of coast might be a nesting area for a group of adult loggerhead females, not necessarily with a strict fidelity to a specific beach.

Another potential nesting area is the tract of coast near Menfi, where three nests were recorded in the period 1993-2003 (Mingozzi et al., 2007), one in 2006 (A. Napoli, pers. comm.) and one in 2011 (present results). The nest in Palermo was the first ever recorded in the northern coast of Sicily, although several nest records are known from other Tyrrhenian coasts of Italy (Mingozzi et al., 2007).

Table 1. Incubation and hatching success data of seven loggerhead sea turtle nests in Sicily in 2011.

Nest	Place	Nesting	First emergence	Min incubation period (days)	Emergence (days)	N eggs	N Hatched eggs	Hatching success (%)	Dead hatchlings
A	Giallonardo (AG)	26/06/11	13/09/11	79	5	80	11	13.8	2
B	Palermo (PA)	11/07/11	not hatched			90	0	0.0	
C	Punta Grande (AG)	13/07/11	16/09/11	65	not available	93	12	12.9	0
D	Giallonardo (AG)	15/07/11	20/09/11	67	8	107	70	65.4	0
E	Giallonardo (AG)	02/08/11	10/10/11	69	10	96	78	81.3	5
F	Giallonardo (AG)	06/08/11	not hatched			100	0	0.0	
G	Porto Palo di Menfi (AG)	09/08/11	18/10/11	70	3	119	22	18.5	1

Table 2. Hatchlings measurements and sand temperatures for six loggerhead sea turtle nests in Sicily in 2011.

Nest	Temperatures			Hatchlings mean ± SD (range; n)	
	Monitored period (days)	Coverage of the inc. period (%)	mean ± SD (range; n) (°C)	Carapace Length (mm)	Weight (g)
A	29 Jul - 13 Sep	58.2	26.5 ± 0.5 (24.4-27.3; n = 35)	40.8 ± 0.9 (39.3-42.5; n = 19)	15.7 ± 0.9 (14.0-17.0; n = 19)
B	22 Jul - 28 Sep	-	28.9 ± 1.5 (24.0-30.5; n = 69)		
C	29 Jul - 24 Sep	87.7	27.3 ± 0.8 (25.6-28.3; n = 22)		
D	29 Jul - 20 Sep	79.1	26.6 ± 0.6 (24.4-27.4; n = 41)	40.5 ± 1.4 (39.0-43.5; n = 10)	15.0 ± 1.6 (11.0-16.0; n = 10)
E	3 Aug - 10 Oct	98.6	26.1 ± 1.0 (22.9-27.3; n = 47)	41.3 ± 0.8 (39.5-42.5; n = 13)	16.6 ± 0.9 (15.0-18.0; n = 13)
F	24 Sep - 20 Oct	-	23.2 ± 2.1 (19.8-26.2; n = 15)		

Overall, hatching success was very low in 2011 nests, and also in one monitored nest in 2005 (25.8%; n = 66; Galia et al., 2006). Only two nests (D, E) had a hatching success close to the one observed in Zakynthos island (71.5%), a major loggerhead sea turtle nesting site in the Mediterranean (Margaritoulis, 2005). In other Italian nesting sites, the mean hatching success was 86% (Calabria) (Mingozzi et al., 2007) and 81.5% (Lampedusa) (Prazzi et al., 2010). The high variability within the same beach suggests that environmental factors varying within the beach may be involved. In general, the beaches of Giallonardo and Punta Grande had rather cold sand temperatures, which may extend the incubation period till the autumn, with high risk of further drops of temperature. For comparison, the average incubation duration in the Mediterranean is less than 60 days (Margaritoulis et al., 2003). In other Italian nesting sites, the mean incubation duration was 46 days (Calabria) (Mingozzi et al., 2007), 67 days (Lampedusa) (Prazzi et al., 2010) and 47 days (Linosa) (Corti et al., 2011). Temperature has also an effect on sex determination, with more males being produced below 29.3 °C (pivotal temperature) and above 52.6 days of incubation period (pivotal incubation duration) (Mrosovsky et al., 2002). The observed sand temperatures and incubation durations suggest that a majority of males are produced by the beaches in the southern coast of Sicily, at least those monitored so far. In the Mediterranean, current knowledge about sex ratio of hatchlings and juveniles is somehow contrasting, with more male juveniles than expected from hatchling sex ratio in monitored nesting sites (Casale et al., 2006). Therefore, male-producing areas, even if scattered over long coastal tracts, may contribute to a better understanding of the sex ratio patterns and may also represent important areas in future scenarios of climate change, with increased temperatures and consequently increased female production (Hawkes et al., 2009). Cold and variable temperature regimes are probably also the reason of the asynchronous emergence (Houghton and Hays, 2001), i.e. hatchlings emerging in small groups and not altogether.

The only mtDNA haplotype observed in the analyzed clutches (CC-A2.1) is prevalent in the main nesting area in Italy (Calabria), in the major Mediterranean rookeries, and is also common in the Atlantic (Garofalo et al., 2009; Monzon-Arguello et al., 2010).

As a result of this study, we recommend higher monitoring efforts in Sicily in order to identify individual nesting events and nesting sites, by means of both direct monitoring of specific coastal tracts and citizen science initiatives through awareness campaigns. Characterization of thermal features of beaches may also help identifying potential nesting sites and further genetic surveys can help understanding the link with other nesting areas.

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